Chapter 8

Gas puff imaging technique

The CT plasma is composed of fully ionized hydrogen and emits visible light only by exciting bound state impurities. Here we have enhanced light emission by puffing a cloud of neutral helium into the transverse viewing chamber at the end of CTIX.

The neutral gas is injected about a millisecond before the formation of the hydrogen CT plasma. The helium is then excited via electron impact, and emits visible light as the CT plasma washes through the gas puff.

Density fluctuations in the plasma have been detected using fast cameras in addition to plasma density probes and magnetic field probes. Gas puff imaging with high speed cameras are beginning to provide new insight into the plasma physics at work on the CTIX accelerator. In combination with existing diagnostics, wave phenomena and turbulent flow states are being observed. Analysis of this new data is underway, with the hope of understanding the nonlinear physics at work in the CTIX plasma.

Late puffing causes helium to be localized near outlet. A target chamber with large windows (0.5 m by 0.2 m) that allow transverse imaging of a large volume of plasma with fast digital cameras at sub-microsecond exposures. Neutral gas puffing in the target region greatly enhances plasma brightness, and spatial variation of image brightness can be used to infer the spatial fluctuations of

the plasma electron flux density. These fluctuations have been observed with fast intensified and non-intensified cameras, with and without the use of narrow bandpass optical filters.

Some coherent density waves have been measured, and we are working to resolve the structure of shocks and turbulence that are expected to occur in the interaction region. By varying the CT injection velocity, the magnetic Reynolds number of the plasma flow can be controlled, and a large dynamical operating space can be explored.Accelerator gas puffing, timing sequence, valve and pulser design, valve output vs applied voltage.

8.1 Excitation dynamics

We see that light emission as a function of time correlates well with electron density as measured with Langmuir probes (LMP) at floating potential, drawing electron current. The top graph shows the light emission measured along two different chords in the transverse viewing chamber. Photomultiplier tubes (PMT's) were used with a pair of adjustable apertures in order to limit the input light to a narrow chord. The first large peak in both graphs corresponds to the passage of the CT plasma through the drift section, while the second broader peak is the trailing plasma. [ref]

8.2 Implementations on CTIX drift section

8.3 Cameras

8.4 Spectral measurements

8.5 quad PMT and LMP measurements